A NOTE ON THE HISTORY OF SUBMARINE WAR

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THE history of submarine war may be said to begin with the second half of the sixteenth century, when its two main principles or aims were first formulated, both by English seamen. Sir William Monson, one of Queen Elizabeth's admirals, in his famous *Naval Tracts,* suggests that a powerful ship may be sunk much more easily by an under-water shot than by ordinary gunfire. His plan is "to place a cannon in the hold of a bark with her mouth to the side of the ship: the bark shall board, and then to give fire to the cannon that is stowed under water, and they shall both instantly sink: the man that shall execute this stratagem may escape in a small boat hauled to the other side of the bark."

This is the germinal idea from which sprang the submarine mine and torpedo; and the first design for a submarine boat was also produced by the English Navy in the same generation. The author of this was William Bourne, who had served as a gunner under Sir William Monson. His invention is described in his book of *Inventions or Devises,* published in 1578, and is remarkable for its proposed method of solving the problem of submersion. This is to be achieved by means of two side tanks into which water can be ad-

mitted through perforations, and from which it can be blown out again by forcing the innerside of each tank outwards. These false sides are made tight with leather suckers and moved by winding hand-screws—a crude and inefficient mechanism, but a proof that the problem had been correctly grasped. For a really practical solution of this and the many other difficulties involved in submarine navigation, the resources of applied science were then hopelessly inadequate; it was not until after more than 300 years of experiment that inventors were in a position to command a mechanism that could carry out their ideas effectively.

The record of these three centuries of experiment is full of interest, for it shows us a long succession of courageous men taking up one after another the same group of scientific problems and bringing them, in spite of all dangers and disasters, gradually nearer to a final solution. Many nations contributed to this work, but especially the British, the American, the Dutch, and French, the Spanish, the Swedish, the Russian, and the Italian. The part played by each of them has been, on the whole, characteristic. The British were the first, as practical seamen, to put forward the original idea, gained from the experience of their rivalry with Spain; they have also succeeded, at the end of the experimental period, in making the best combined use of the results of the long collaboration. A Dutchman built the first practical submarine and achieved the first successful dive. The Americans have made the greatest number of inventions, and of daring experiments in earlier wars. The French have shown, as a nation, the strongest interest in the idea,

and their Navy was effectively armed with submarines ten years before that of any other Power. To them, to the Dutch, and to the Italians belongs the credit of that indispensable invention the optic tube or periscope. The Swedes and Russians have the great names of Nordenfelt and Drzewiecki to their credit; the Germans alone, among the eight or nine nations interested in the science of naval war, have from first to last contributed almost nothing to the evolution of the submarine. The roll of submarine inventors includes about 175 names, of which no less than 60 belong to the English-speaking peoples, but only 6 to Germany. Among these six the name of Bauer is remembered as that of a courageous experimenter, persevering through a career of repeated failures; but neither he nor any of his fellow-countrymen advanced the common cause by the suggestion of a single idea of value. Finally, when the German Admiralty, after the failure of their own Howaldt boat, decided to borrow the Holland type from America, it was no German, but the Spanish engineer d'Equevilley, who designed for them the first five U-boats, of which all the later ones are modifications. The English Admiralty were in no such straits; they were only one year before the Germans in adopting the Holland type, but the native genius at their disposal has enabled them to keep ahead of their rivals from that day to this, in the design, efficiency, size, and number of their submarine vessels; and this result is exactly what might have been expected from the history of submarine invention.

That history is the record of the discovery and solution of a number of problems, the first five of which

may be said to be the problems of submersion, of stability, of habitability, of propulsion and speed, and of offensive action. If we take these in order, and trace the steps by which the final solution was approached, we shall be able to confirm what has been said about the work contributed by successive inventors.

1. We have seen that for submersion and return to the surface Bourne had at the very beginning devised the side tank to which water could be admitted and from which it could be "blown out" at will. Bushnell, a remarkable inventor of British-American birth, substituted a hand-pump in his boat of 1773 for the mechanism proposed by Bourne. In 1795 Armand-Maizière, a Frenchman, designed a steam submarine vessel to be worked by "a number of oars vibrating on the principle of a bird's wing." Of these "wings," one lot were intended to make the boat submerge. Nothing came of this proposal, and for more than a century tanks and pumps remained the sole means of submersion. In 1893 Haydon, an American, invented a submarine for the peaceful purpose of exploring the ocean bed; its most important feature was the method of submersion. This was accomplished by means of an interior cylindrical tank with direct access to the sea, and fitted with two powerfully geared pistons. By simply drawing the pistons in or pushing them out the amount of water ballast could be nicely regulated, and the necessity for compressed air or other expellants was avoided. This device would have given great satisfaction to William Bourne, the Elizabethan gunner, whose original idea, after more than two centuries,

it carried out successfully. Finally, in 1900 the American inventor Simon Lake, in his *Argonaut II,* introduced a new method of diving. For the reduction of the vessel's floatability he employed the usual tanks, but for "travelling" between the surface and the bottom he made use of "four big hydroplanes, two on each side, that steer the boat either down or up." Similar hydroplanes, or horizontal rudders, appeared in the later Holland boats, and are now in common use in all submarine types.

Lake was of British descent, his family having emigrated from Wales to New Jersey; but he owed his first interest in submarine construction and many of his inventive ideas to the brilliant French writer, Jules Verne, whose book *Twenty Thousand Leagues under the Sea* came by chance into his hands when he was a boy ten years old, and made a lasting impression upon him.

2. Next to the power of submersion, the most necessary quality in a submarine is that of stability under water. The most obvious method of securing this is by water ballast, which was probably the first means actually employed. Bushnell in 1773 substituted a heavy weight of lead, as being more economical of space and better suited to the shape of his boat, which resembled a turtle in an upright position. The leaden ballast, being detachable at will, also acted as a safety weight, to be dropped at a moment of extreme urgency. In the *Nautilus,* built in 1800 by the famous engineer Robert Fulton, an American of English birth and education, the leaden weight reappeared as a keel, and was entirely effective. The inventor, in a trial at

Brest in 1801, dived to a depth of 25 feet and performed successful evolutions in different directions for over an hour. Bauer, fifty years later, returned to the ballast principle, and used both a water tank and a safety weight in the same boat. The results were disastrous. His first submarine sank at her first trial in Kiel Harbour, and was never refloated; his second was built in England, but this, too, sank, with great loss of life; his third, *Le Diable Marin,* after several favourable trials at Cronstadt, fouled her propellers in a bed of seaweed, and the releasing of the safety weights only resulted in bringing her bows to the surface. The crew escaped with difficulty, and the vessel then sank.

Three years later, in 1861, Olivier Riou designed two boats, in both of which stability was to be preserved automatically by the device of a double hull. The two cylinders which composed it, one within the other, were not fixed immovably to one another, but were on rollers, so that if the outer hull rolled to the right the inner rolled to the left. By this counterbalancing effect it was estimated that the stability of the vessel would be absolutely secured; but nothing is recorded of the trials of these boats. The celebrated French inventors Bourgois and Brun reintroduced the principle of water tanks, combined with a heavy iron ballast keel; but in 1881 the Rev. W. Garrett, the English designer of the Nordenfelt boats, invented a new automatic mechanism for ensuring stability. This consisted of two vertical rudders with a heavy pendulum weight so attached to them that if the boat dipped out of the horizontal the pendulum swung down and

gave the rudders an opposite slant which raised the vessel again to a horizontal position. This arrangement, though perfect in theory, in practice developed fatal defects, and subsequent designers have all returned to the use of water tanks, made to compensate by elaborate but trustworthy mechanism for every loss or addition of weight.

3. For the habitability of a submarine the prime necessity is a supply of air capable of supporting life during the period of submersion. The first actual constructor of a submarine—Cornelius van Drebbel, of Alkmaar, in Holland—was fully aware of this problem, and claimed to have solved it not by mechanical but by chemical means. His improved boat, built in England about 1622, carried twelve rowers besides passengers (among whom King James I is said to have been included on one occasion), and was successfully navigated for several hours at a depth of 10 to 15 feet. "Drebbel conceived," says Robert Boyle, in 1662, "that 'tis not the whole body of the air but a certain Quintessence (as chemists speake) or spirituous part of it that makes it fit for respiration, which being spent, the grosser body or carcase (if I may so call it) of the Air, is unable to cherish the vital flame residing in the heart: so that (for aught I could fathom) besides the Mechanicall contrivance of his vessel he had a Chymicall liquor, which he accounted the chief secret of his Submarine Navigation. For when from time to time he perceived that the finer and purer part of the Air was consumed or overclogged by the respiration and steames of those that went in his ship, he would, by unstopping a vessel full

of the liquor, speedily restore to the troubled air such a proportion of vital parts as would make it again for a good while fit for Respiration."

Drebbel, who was a very scientific man, may possibly have discovered this chemical secret; if so, he anticipated by more than 200 years a very important device now in use in all submarines, and, in any case, he was the originator of the idea. But his son-in-law, a German named Kuffler, who attempted after Drebbel's death to exploit his submarine inventions, was a man of inferior ability, and either ignorant of the secret or incapable of utilising it. For another century and a half submarine designers contented themselves with the small supply of air which was carried down at the time of submersion. Even the *Turtle*—Bushnell's boat of 1773—which has been described as "the first submarine craft which really navigated under serious conditions," was only built to hold one man with a sufficient supply of air for half an hour's submersion. This was a bare minimum of habitability, and Fulton, twenty-five years later, found it necessary to equip his *Nautilus* with a compressed air apparatus. Even with this the crew of two could only be supplied for one hour. In 1827 the very able French designer, Castéra, took out a patent for a submarine lifeboat, to which air was to be supplied by a tube from the surface, protected by a float from which the whole vessel was suspended. The danger here was from the possible entry of water through the funnel, and the boat, though planned with great ingenuity, was never actually tried. Bauer in 1855 fitted his *Diable Marin* with large water tubes running for 30 feet along the top

of the boat, and pierced with small holes, from which, when desired, a continual rain could be made to fall. This shower bath had a purifying effect on the vitiated air; but it had obvious disadvantages, and there is no record of its having been put into actual use before the unfortunate vessel sank, as before related. In the same year a better principle was introduced by Babbage, an English inventor, who designed a naval diving-bell fitted with three cylinders of compressed air. His method was followed by Bourgois and Brun, whose boats of 1763-5 carried steel reservoirs with compressed air at a pressure of at least 15 atmospheres. The principle was now established, and was adopted in the Holland and Lake boats, and in all subsequent types, with the addition of chemical treatment of the vitiated air.

4. Propulsion comes next in the logical order. The various solutions of this problem have naturally followed the successive steps in the development of machinery. Drebbel made use of oars; Bushnell, though he speaks of "an oar," goes on to describe it as "formed upon the principle of the screw . . . its axis entered the vessel, and being turned one way rowed the vessel forward, but being turned the other way rowed it backward: it was made to be turned by the hand or foot." Moreover, he had a similar "oar" placed at the top of the vessel which helped it to ascend or descend in the water. The conclusion seems unavoidable that to this designer belongs the honour of having invented the screw propeller, and also of having put it into successful operation. Fulton adopted the same method of propeller and hand-winch in his *Nautilus;*

but his large vessel, the *Mute,* built in 1814 to carry 100 men, was driven by a silent steam-engine. He died during the trials of this boat, and further experiment with it seems to have been abandoned, possibly owing to the greater interest excited by his first war steamer, which was building at the same time. A regrettable set-back was thus caused; for forty years no one experimented with any kind of submarine propulsory engine. Bauer in 1855 could devise no better method of working his propellers than a system of 7-foot wheels turned by a pair of men running on a treadmill. At this same moment, however, a more fruitful genius was at work; a French professor, Marié-Davy, designed a submarine in which the propeller was driven by an electro-magnetic engine, placed in the stern of the ship, with batteries forward. The idea was a valuable one, with a great future before it, though for the moment it achieved no visible success. A year later, in 1855, the famous British engineer, James Nasmyth, designed a "submerged mortar," which was in reality a ram of great weight and thickness, capable of being submerged level with the surface and driven at a speed of over 10 knots by a steam-engine with a single high-pressure boiler. But, in spite of the simplicity and power of this boat, it was finally rejected as being neither invisible nor invulnerable to an armed enemy; and in their desire to obtain complete submersion, the French inventors of the next few years—Hubault, Conseil, and Masson—all return to the hand-winch method of propulsion. Riou, however, in 1861, adopted steam for one of his boats and electric power for the other; and in 1863 the American engineer,

Alstitt, built the first submarine fitted with both steam and electricity. Steam was also used in the *Plongeur* of Bourgois and Brun, which was completed in the same year.

The American Civil War then gave a great opportunity for practical experiments in torpedo attack; but the difficulty of wholly submerged navigation not having been yet solved, the boats used were not true submarines, but submersibles. Their propulsion was by steam, and their dimensions small. A more ambitious invention was put forward in 1869 by a German, Otto Vogel, whose design was accepted by the Prussian Government. His submersible steamship was to be heavily armed, and was "considered the equal of a first-class ironclad in defensive and offensive powers." These powers, however, never came into operation.

Inventors now returned to the designing of true submarines, and after the Frenchman Constantin, the American Halstead, and the Russian Drzewiecki had all made the best use they could of the hand-winch or the pedal for propulsion, three very interesting attempts were made in 1877-8 to secure a more satisfactory engine. Olivier's boat, patented in May, 1877, was to be propelled by the gases generated from the ignition of high explosives, the massed vapours escaping through a tube at the stern. This ingenious method was, however, too dangerous for practical use. Purman's design of 1878 included a propeller rotated by compressed air. But the English boat of the same date —Garrett's *Resurgam*—was much the most noteworthy of the three, and introduced a method which may in the future be brought to perfection with good

results. In this boat the motive force was steam, and propulsion under water, as well as on the surface, was aimed at and actually attained. In her trials the vessel showed herself capable of navigating under water for a distance of 12 miles, by getting up a full head of steam in a very powerful boiler with the aid of a blower, before diving; then by shutting the fire-door and chimney, and utilising the latent heat as long as it would last. When the heat was exhausted it was of course necessary to return to the surface, blow up the fire again, and re-charge the boiler with water. The vessel was remarkably successful, and had the great merit of showing no track whatever when moving under water. She was lost by accident, but not until she had impressed Nordenfelt, the Swedish inventor, so strongly that he secured the services of her designer (Garrett), for the building of his own submarine boats. The first of these appeared in 1881.

In the same year were patented Woodhouse's submarine, driven by compressed air, and Génoud's, with a gas-engine worked by hydrogen, which is said to have attained a speed of between 4 and 5 knots. Blakesley in 1884 proposed to use steam raised in a fireless boiler heated by a chemical composition. In 1884, too, Drzewiecki produced the fourth of his ingenious little boats, driven this time not by pedals but by an electric motor. His example was followed by Tuck, of San Francisco, shortly afterwards, and by Campbell and Ash in their *Nautilus,* which in 1886 underwent very successful trials in the West India Docks at Tilbury, near London. In 1886, D'Allest, the celebrated French engineer, designed a submarine

fitted with a petrol combustion engine; but the question of propulsion may be said to have been finally settled within a few months after this in favour of the electro-motor, for Gustav Zédé's famous *Gymnote,* which was actually put on the stocks in April, 1887, attained in practice a surface speed of 10 knots and a maximum of 7 to 8 knots under water. This success saved designers the trouble of further experiments with ingenious futilities.

5. We have so far been considering the development of the submarine as a vessel navigable under water, without reference to the purpose of offence in war. But this purpose was from the first in view, and formed with almost all the inventors recorded the main incentive of their efforts. The evolution of the submarine weapon has been much simpler and more regular than that of the vessel which was to use it; but it has been equally wonderful, and the history of it is equally instructive. Briefly, the French, in this department, as in the other, have shown the most imaginative enthusiasm, the Americans the greatest determination to achieve results even with crude or dangerous means, while the English have to their credit both the earliest attempts in actual war and the final achievement of the automobile torpedo. Of the Germans, as before, we must record that they have contributed nothing of any scientific value.

Sir William Monson's device of a bark with an under-water cannon and an accompanying boat was soon developed by the English Navy into the more practicable mine, self contained and floating, to be towed by a boat or submarine. In January, 1626, the King

gave a warrant to the Master of the Ordnance "for the making of divers water mines, water-petards, and boates to goe under water." In June of the same year the Duke of Buckingham, then commanding the naval expedition for the relief of La Rochelle, issued a warrant for the delivery of "50 water-mynes, 290 water-petards, and two boates to conduct them under water." Pepys, in his diary for March 14, 1662, mentions a proposal by Kuffler of an "engine to blow up ships." He adds: "We doubted not the matter of fact, it being tried in Cromwell's time, but the safety of carrying them in ships," and probably this distrust of Drebbel's German subordinate proved to be justified, for nothing more is heard of the design. The attempts referred to as made "in Cromwell's time" may have been Prince Rupert's attack on Blake's flagship, the *Leopard,* in 1650. The engine then used was not a submarine one, but an infernal machine concealed in an oil-barrel, brought alongside in a shore-boat by men disguised as Portuguese, and intended to be hoisted on board the ship, and then fired by a trigger and string. A more ingenious "ship-destroying engine" was devised by the Marquess of Worcester in 1655. This was evidently a clock-machine, for it might be affixed to a ship either inside, by stealth, or outside, by a diver, "and at an appointed minute, though a week after, either day or night, it shall infallibly sink that ship."

The clock-machine was actually first tried in action in 1776 by Bushnell—or, rather, by Sergeant Lee, whom he employed to work his *Turtle* for him. The attack by this submarine upon the *Eagle,* a British 64-

gun ship lying in the Hudson River, was very nearly successful. The *Turtle* reached her enemy's stern unobserved, carrying a mine or magazine of 150 lb. of powder, and provided with a detachable woodscrew which was to be turned until it bit firmly on the ship's side. The mine was then to be attached to it and the clockwork set going. The woodscrew, however, bit upon some iron fittings instead of wood, and failed to hold; the tide also was too strong for Lee, who had to work the woodscrew and the propeller at the same time. He came to the surface, was chased by a guard-boat, and dived again, abandoning his torpedo, which drifted and blew up harmlessly when the clockwork ran down. Lee escaped, but the *Turtle* was soon afterwards caught and sunk by the British. Bushnell himself in the following year attacked the *Cerberus* with a "machine" consisting of a trigger-mine towed by a whale-boat. He was detected and his mine captured by a British schooner, the crew of which, after hauling the machine on deck, accidentally exploded it themselves, three out of the four of them being killed.

In 1802, Fulton's *Nautilus,* in her trials at Brest, succeeded in blowing up a large boat in the harbour. In 1814 his submersible, the *Mute,* was armed with "columbiads," or immensely strong under-water guns, which had previously been tried with success on an old hulk. Similar guns were tried nearly fifty years later by the Spanish submarine designer, Monturiol. But the offensive weapon of the period was the mine, and the ingenuity of inventors was chiefly directed to methods of affixing it to the side or bottom of the ship to be destroyed. One of these was the use of long

gloves of leather or rubber, protruding from the interior of the submarine, invented by Castéra in 1827, and adopted by Bauer, Drzewiecki, and Garrett in succession. But the device was both unhandy and dangerous; there would often be great difficulty in manœuvring the boat into a position in which the gloves would be available, and they could not be made thick enough to withstand the pressure of any depth of water. Practical military instinct demanded a method of launching the mine or torpedo against the target, and the first attempts were made by placing a trigger-mine at the end of a spar carried by the nose of the attacking boat. In October, 1863, during the American Civil War, the forts of Charleston were in danger from the accurate fire of the Federal battleship *Ironsides,* and Lieutenant Glassell was ordered to attack her in the submarine *David.* He had no difficulty in getting near his enemy and exploding his torpedo, but he had misjudged his distance, and only succeeded in deluging the *Ironsides* with a column of water. The submarine was herself severely injured by the explosion, and had to be abandoned. A second *David,* commanded by Lieutenant Dixon, in February, 1864, attacked the *Housatonic* off the same harbour, and, in spite of the greater vigilance on the part of Admiral Dahlgren's officers, succeeded in reaching the side of the battleship, where she lay for the space of a minute, making sure of her contact. The mine was then fired; the *Housatonic* rose on a great wave, listed heavily, and sank at once. The *David,* too, disappeared, and it was found three years afterwards that she had been irresistibly sucked into the hole made in

her enemy's side. After this, experiments were made with drifting and towing mines, and with buoyant mines to be released at a depth below the enemy's keel; but by 1868 the invention of the automobile torpedo by the English engineer Whitehead, of Fiume, solved the problem of the submarine offensive in the most sudden and conclusive manner.

Whitehead's success arose out of the failure of an enterprising Austrian officer, Captain Lupuis, who had been trying to steer a small fireship along the surface of the water by means of ropes from a fixed base either on shore or in a parent ship. The plan was a crude one, and was rejected by the Austrian naval authorities; it was then entrusted to Whitehead, who found it incapable of any practical realisation. He was, however, impressed with Lupuis' belief in the value of a weapon which could be operated from a distance, and though he failed in designing a controllable vessel, he conceived instead the idea of an automobile torpedo, and after two years' work constructed it in a practicable form. It has been spoken of as "the only invention that was perfect when devised," and it certainly came very near perfection at the first attempt; but it was erratic, and could not be made to keep its depth. In 1868, however, Whitehead invented the "balance-chamber," which remedied these defects, and brought two finished torpedoes to England for trial. They were fired by compressed air from a submerged tube, and at once proved capable of averaging 7½ to 8½ knots up to 600 yards, and of striking a ship under way up to 200 yards. The target—an old corvette in the Medway—was sunk on to the mud by the first

shot, at 136 yards, and immediately after the trials the British Government bought the secret and other rights. Imitations were, of course, soon attempted in other countries, and a type called the Schwartzkopf was for some years manufactured in Berlin, and used in the German and Spanish navies. It was also tried by the Italians and Japanese; but it failed in the end to hold its own against the Whitehead.

The automobile torpedo was at first used only for the armament of ordinary warships; it was not until 1879 that an American engineer named Mortensen designed a submarine with a torpedo-tube in her bows. His example was followed by Berkeley and Hotchkiss in 1880, by Garrett in his first Nordenfelt boat of 1881, and by Woodhouse and by Lagane in the same year. Even after this, Drzewiecke, Tuck, and D'Allest designed their submarines without torpedo-tubes; but these were, in fact, indispensable, and the use of the Whitehead torpedo has been for the last twenty years assumed as the main function of all submarines designed for war.

The difficulties of construction, propulsion, and armament having now been solved, the submarine at last took its place among the types of warships in the annual lists. From the first, England and France held a marked lead, and in *Brassey's Naval Annual* for 1914 the submarine forces of the chief naval Powers were given as follows:—Great Britain, 76 vessels built and 20 ordered; France, 70 and 23; the United States of America, 29 and 31; Germany, 27 and 12. The technical progress of the four services was prob-

ably more equal than their merely numerical strength; but it was not altogether equal, as may be seen by a brief comparison of the development of the British and German submarine types between 1904 and 1914. The eight British A-boats of 1904 had a displacement of 180 tons on surface (207 tons submerged). The German U 1 of 1904-6 was slightly larger—197 (236) —but in every other respect inferior: its horse-power was only 250 on surface (100 submerged) as against 550 (150), its surface speed was only 10 knots against 11.5, and it was fitted with only a single torpedo-tube instead of the A-boat's two. This last deficiency was remedied in 1906-8; but the German displacement did not rise above 210 (250) nor the horse-power above 400 (150), while the British advanced to 550 (600) and 1,200 (550). By 1913 the Germans were building boats of 650 (750) displacement and 1,400 (500) horse-power; but the British were still ahead with 725 (810) and 1,750 (600), and had also a superiority in speed of 16 (10) knots to 14 (8). The last German boats of which any details have been published are those of 1913-4, with a displacement of about 800 tons on the surface and a maximum speed of 18 (7) knots. The British F-boats of the same date are in every way superior to these, with a displacement of 940 (1,200), a speed of 20 (12) knots, and an armament of 6 torpedo-tubes against the German 4. The comparison cannot be carried, in figures, beyond the date of the outbreak of war; but it is well known among the Allies of Great Britain that her superiority has been amply maintained, and in certain important respects materially increased. The Germans cannot

deny this fact with any plausibility, for their naval Administration have not had the frequent opportunities which the British Admiralty have enjoyed during the war—of inspecting the details of their enemies' submarine construction.

The three years of conflict have, however, afforded an opportunity for a further and even more important comparison. The problems of submarine war are not all material problems; moral qualities are needed to secure the efficient working of machinery, the handling of the ships under conditions of danger and difficulty hitherto unknown in war, and the conduct of a campaign with new legal and moral aspects of its own. In two of these departments—those of efficiency and seamanship—the Germans have achieved a considerable show of success, though it could be, and in time will be, easily shown that the British naval service has been more successful still. But in the domain of policy and international morality, the comparison becomes no longer a comparison but a contrast—the new problems have been dealt with by the British in accordance with the old principles of law and humanity; by the Germans they have not been solved at all—the knot has simply been cut by the cruel steel of the pirate and murderer. The methods of the U-boat campaign have not only brought successive defeats upon Germany, they will in the end cripple her commerce for many years; and, in addition to her material losses, she will suffer the bitter consequences of moral outlawry.

Of the general efficiency of the German submarines it is too soon to speak, but it may be readily admitted that they have done well. We know, of course, many

cases of failure—cases in which boats have been lost by defects in their engines, by running aground through mishandling in shoal waters, or by inability to free themselves from British nets. On the other hand, the German patrol has been kept up with a degree of continuity which, when we remember the dislocation caused by their severe losses, is a proof of good workmanship and determination. But the British submarine service has to its credit a record of work which, so far as can be judged from the evidence available, is not only better, but has been performed under more difficult and dangerous circumstances. In the North Sea, patrolling has been carried out regularly, in spite of minefields and of possible danger from the British squadrons, which must, of course, be avoided as carefully as if they were enemies. The German High Seas Fleet has been for the most part in hiding; but on the rare and brief occasions when their ships have ventured on one of their furtive raids, British submarines have done their part, and the only two German dreadnoughts which have risked themselves outside Kiel since their Jutland flight were both torpedoed on the same day. Better opportunities were found in the Baltic, where British submarines, in spite of German and Swedish nets, icefields, and the great distance of bases, succeeded in establishing a complete panic by torpedoing a number of German war vessels and the cargo ships which they were intended to safeguard.

But it was in the Gallipoli campaign that the conditions were most trying and most novel. The British submarines detailed for the attack in Turkish waters had to begin by navigating the Dardanelles against a

very rapid current, setting strongly into a succession of bays; they had to pass searchlights, mines, torpedo-tubes, nets, and gunboats; and in the Sea of Marmora they were awaited by a swarm of cruisers, destroyers, and patrol boats of all kinds. Yet, from the very first, they were successful in defeating all these. Boat after boat went up without a failure and maintained herself for weeks at a time without a base, returning with an astonishing record of losses inflicted on the enemy. The boat E 14, Lieutenant-Commander Courtenay Boyle, may be quoted as an example, not because it is an exceptional instance, but because it was the earliest, and supplied valuable information which facilitated the work of those which followed. The passage of the Narrows was made through the Turkish minefield, and its difficulty may be judged by the fact that E 14, during the first 64 hours of the voyage, was diving for 44 hours and 50 minutes. She escaped from a small steamboat, the crew of which endeavoured to catch her periscope, and also from the searchlight and guns of a fort, and from three pairs of trawlers who made their sweep right over her. After she began her patrol work, there was more than one day on which she was under fire the whole day, except when she dived from time to time. Often she found herself dangerously near to Turkish torpedo-boats, and could not understand why they did not attempt to ram her. The difficulty of using her torpedoes was extreme; but she succeeded in hitting and sinking two transports, one of which was 1,500 yards distant and escorted by three destroyers. Finally, when, after twenty-two days patrolling, she began her return voy-

age, she was shepherded by a Turkish gunboat, a torpedo-boat, and a tug, one each side of her and one astern, and all hoping to catch her in the net; but by deep and skilful diving she escaped them, and cleared the net and the minefield at a speed of 7 knots.

Her second patrol extended over twenty-three days. This time the tide was stronger and the weather less favourable. One day it was too rough to bring the boat alongside a brigantine which had surrendered; whereupon Lieutenant R. W. Lawrence swam off to the prize, boarded her alone, and burnt her with her own matches and paraffin. Next day a steamer was torpedoed at 750 yards as she lay off a pier, and nearly two hours later her destruction was completed by a second hit. The total number of steamers, grain dhows, and provision ships sunk on this patrol amounted to no less than ten, and the return voyage was successfully accomplished, the boat tearing clean through an obstruction off Bokali Kalessi.

The third patrol was again twenty-two days. An hour after starting, E 14 had her foremost hydroplane fouled by an obstruction which jammed it for the moment and threw the ship 8 points off her course. After a quick scrape, she got clear, but found afterwards that her guard-wire was nearly cut through. On this trip the wireless apparatus was for a time out of order, but was successfully repaired; eight food ships were burnt or sunk, one of them being a supply-ship of 5,000 tons. The return voyage was the most eventful of all: E 14 came full against the net at Nagara, which had apparently been extended since she went up. The boat was brought up from 80 feet to 45 feet

in three seconds; but was, luckily, only thrown 15 degrees out of her course. For twenty seconds there was a tremendous noise—scraping, banging, tearing, and rumbling—as she passed through what appeared to be two separate obstructions; then she broke away uninjured, but with her bow and periscope standards scraped and scored, and some twin electric wire round her propeller.

The efficiency of the boat and her crew were beyond praise. Since leaving England, E 14 had run over 12,000 miles, and had spent nearly seventy days at close quarters with the enemy in the Sea of Marmora; she had never been in a dockyard or out of running order; she had had no engine defects except such as were immediately put right by her own engine-room staff. Yet she made no claim to be better than her consorts.

Nor did she make any boast of her humane treatment of captured enemies: she merely followed the tradition of the British Navy in this matter, and the principles of law as accepted by all civilised nations. The commander of a submarine, whether British or German, has to contend with certain difficulties which did not trouble the cruiser captains of former wars. He cannot spare, from his small ship's company, a prize crew to take a captured vessel into port; he cannot, except in very rare cases, hope to take her in himself; and, again, if he is to sink her, he cannot find room in his narrow boat for more than one or two prisoners. What he can do is to see that non-combatants and neutrals, at least, shall be exposed as little as possible to danger or suffering; he can give

them boats and supplies and every opportunity of reaching land in safety. No one needs to be told how the Germans, either of their own native cruelty or by the orders of a brutal and immoral Higher Command, have in such circumstances chosen to deal with their helpless fellow-men, and even with women and children, and with the wounded and those attending them.

But it may be well to put in evidence some of the brief notes in which a typical British submarine commander has recorded, as a matter of course, his own method on similar occasions.

"May 8.—Allowed two steamers full of refugees to proceed." "June 19.—Boarded and sank 3 grain dhows; towed crew inshore and gave them some biscuit, beef, and rum and water, as they were rather wet." "June 22.—Let go passenger ship. 23.—Burnt two-master, and started to tow crew in their boat, but had to dive. Stopped 2 dhows; crews looked so miserable that I only sank one and let the other go. 24.—Blew up 2 large dhows; saw 2 heads in the water near another ship; turned, and took them up exhausted, gave them food and drink, and put them on board their own ship." "July 30.—Burnt sailing vessel with no boat, and spent remainder of afternoon trying to find a craft to get rid of the crew into. Found small sailing boat, and got rid of them." "August 3.—Burnt large dhow. Unfortunately, 9 on board, including 2 very old men; and their boat was small, so I had to take them on board and proceed with them close to the shore—got rid of them at 9.30 p.m."

As for the hospital ships, there were numbers of

them coming and going; but, empty or full, it is inconceivable that the British Navy should make war upon hospital ships. Victory it will desire, but not by villainy; defeat it will avoid strenuously, but not by the destructon of the first law of human life. The result is none the less certain; in the history of submarine war, as in that of all naval war, it will inevitably be seen that piracy and murder are not the methods of the strong.